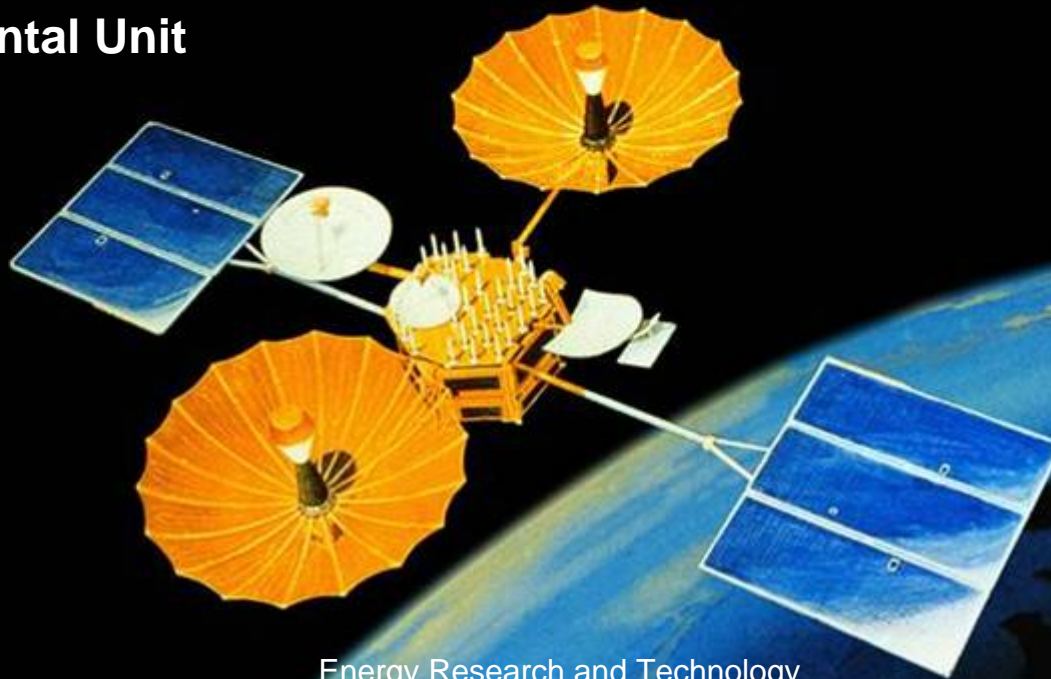


## Hyperspectral Remote Sensing A Tool for Oil Spill Planning, Response, and Restoration

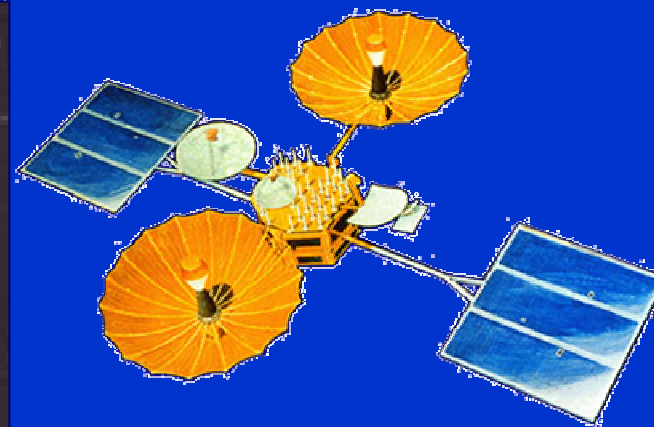
Peter Samuels, Energy Technology Company  
HES, Environmental Unit  
Bellaire Texas





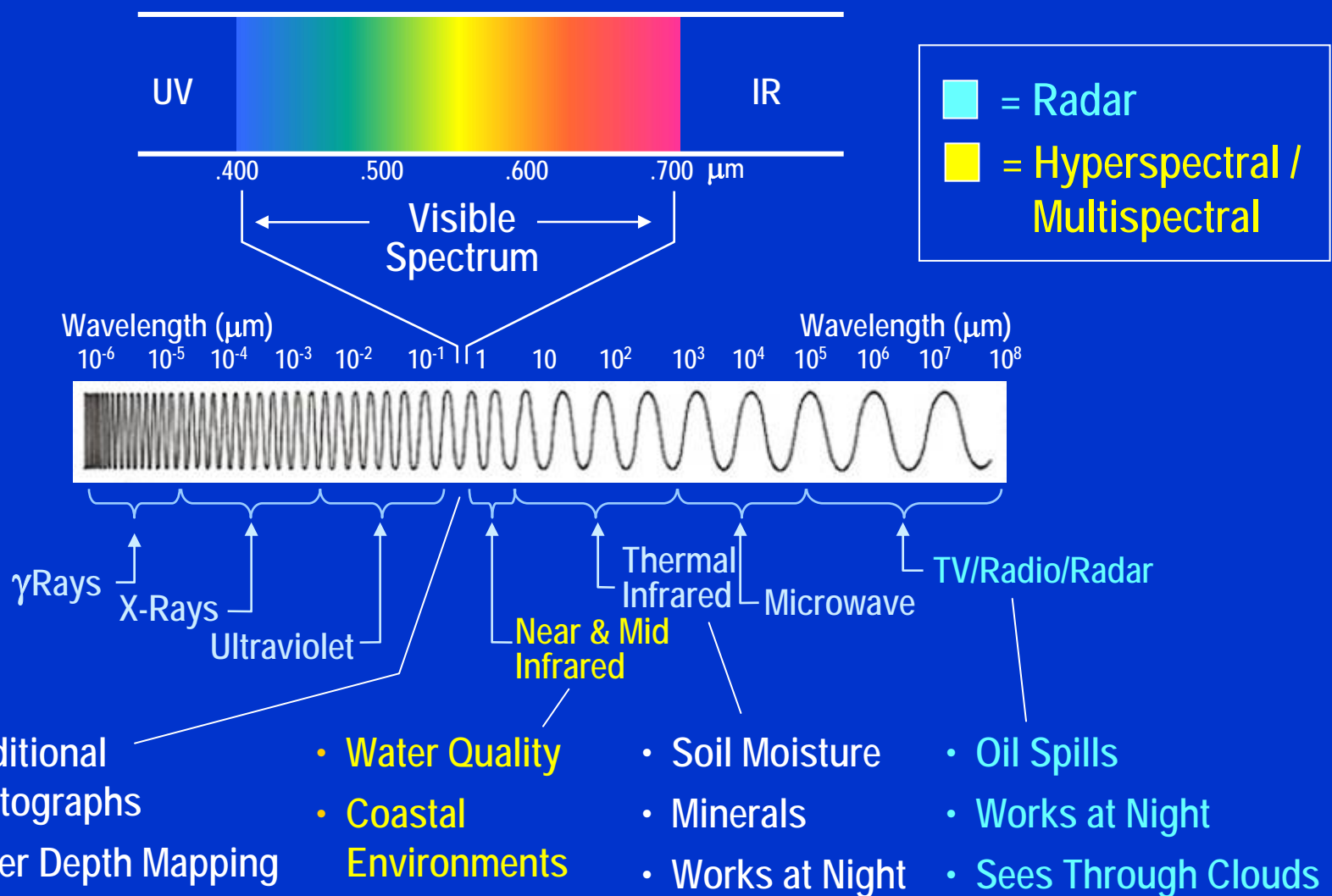
ChevronTexaco

# What is Remote Sensing?

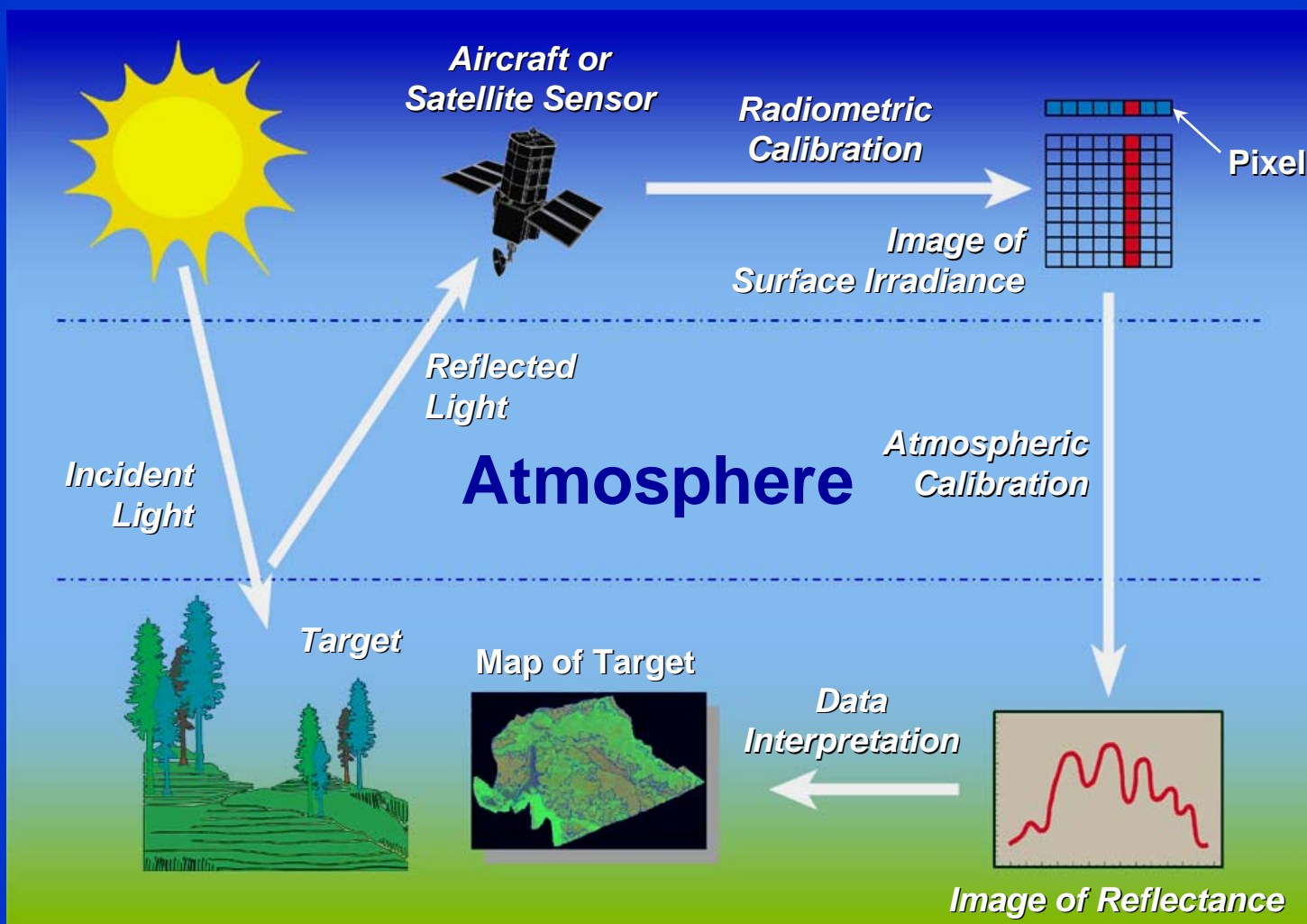


- Use Sensors on Airplanes or Satellites to Obtain Detailed Regional Data Cost-Effectively and Rapidly

# Remote Sensing Allows Us to “See” Beyond the Visible Spectrum

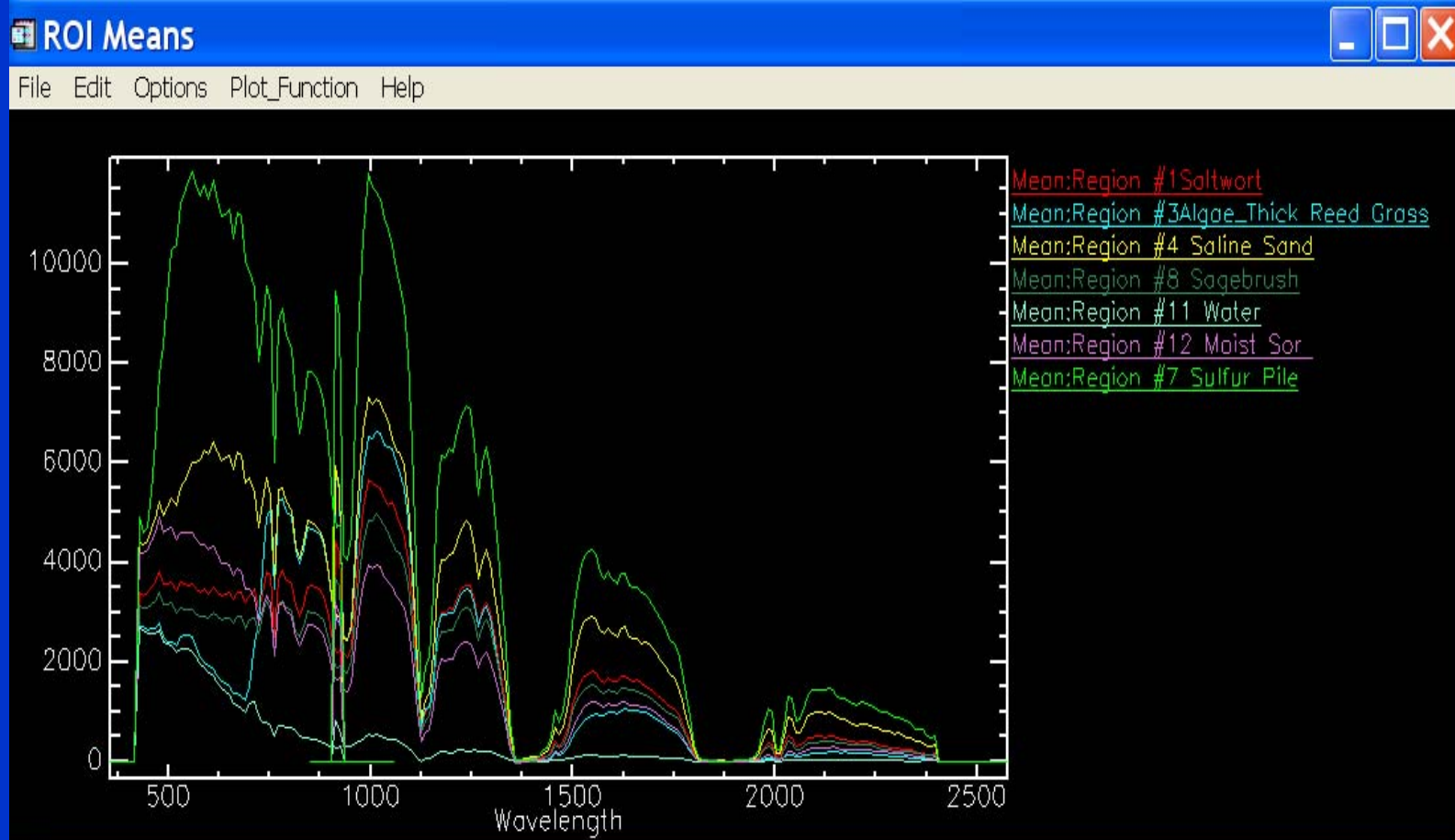


# How Hyperspectral Works: Receives Reflected Sunlight





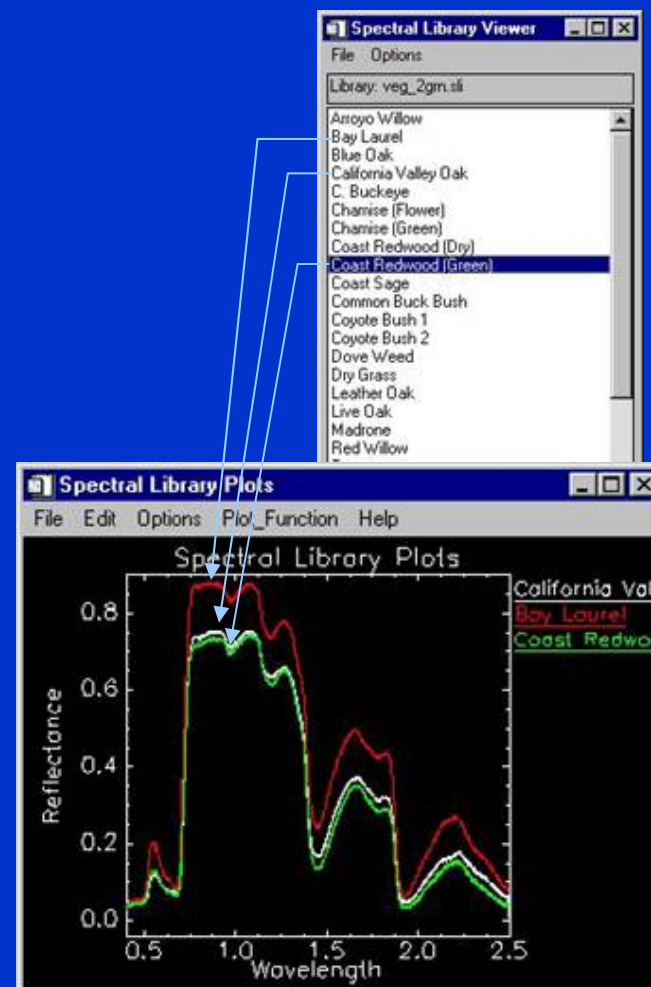
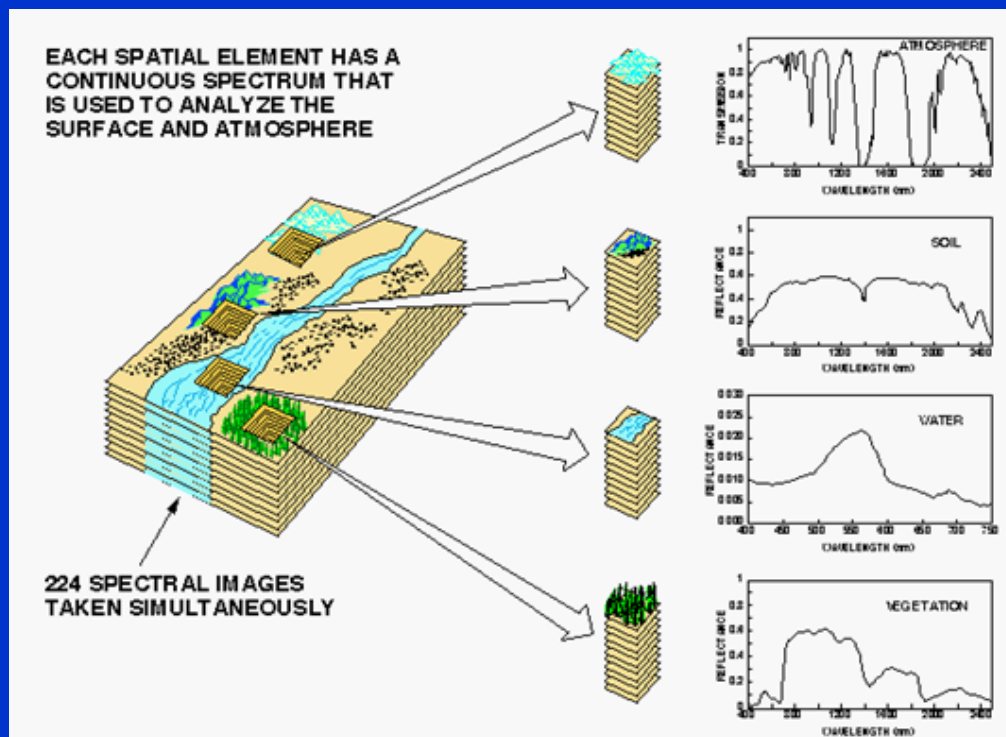
# Hyperspectral Sensors Can Identify Oil From Other Materials



# Spectral Library: Every Material Has a Unique Response



## Hyperspectral Concept



# ChevronTexaco Business Interest in Environmental Remote Sensing



- Understand and Document Environmental Conditions Prior to Operations and Acquisitions
- Manage Existing Operations
- Document Property Condition Prior to Relinquishment
- Respond to Regulatory Agencies, Competitors, and NGOs

## Key Technologies:

- Hyperspectral
- Interferometric Synthetic Aperture Radar (IFSAR)



# ChevronTexaco Environmental Remote Sensing Surveys



**ChevronTexaco**

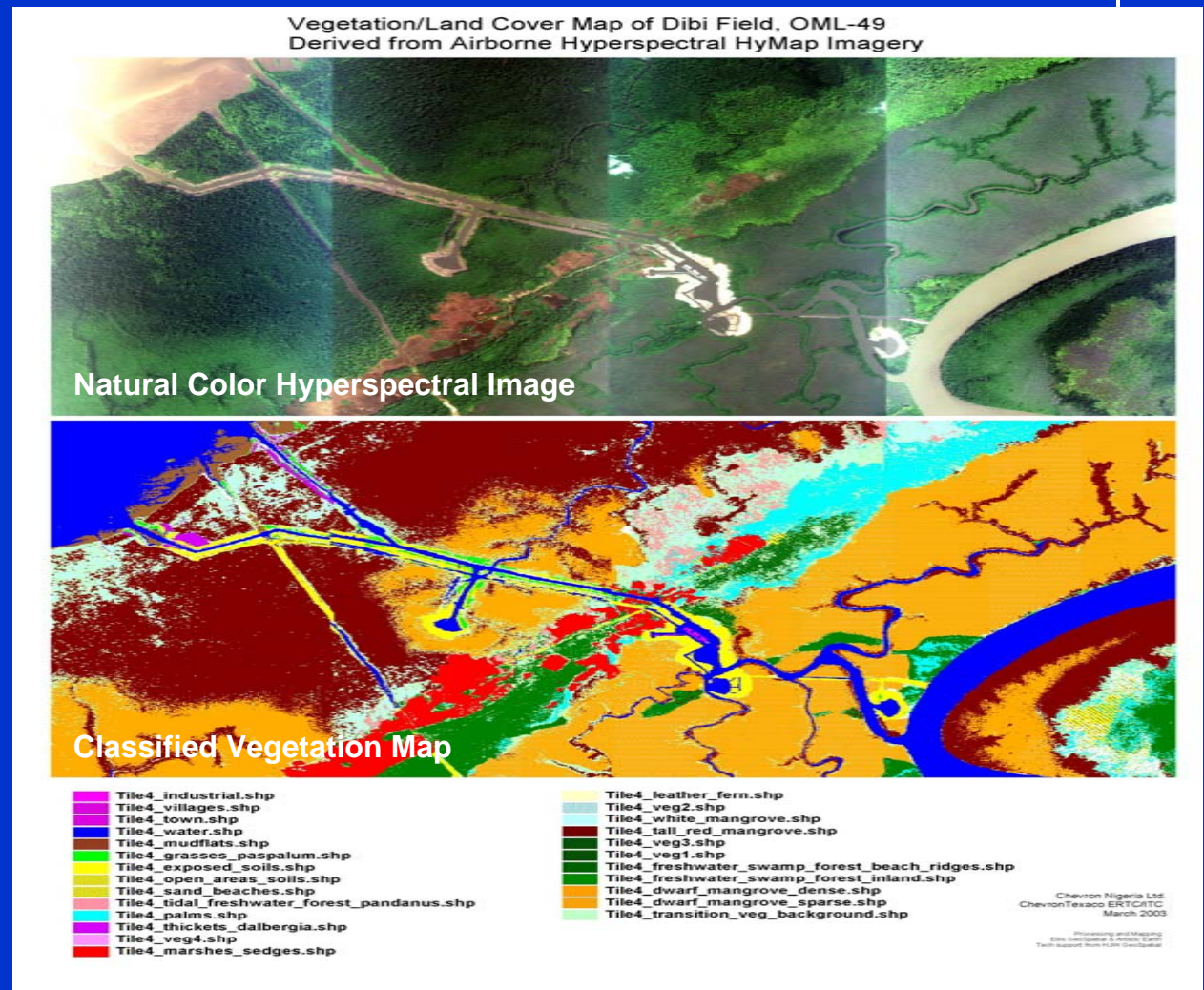
Energy Research and Technology

# Business Uses: Vegetation/Habitat Maps to Assist Site Selection



## Nigeria

- 1999 Hyperspectral airborne imagery used to map vegetation and determine areas suitable for mangrove restoration.



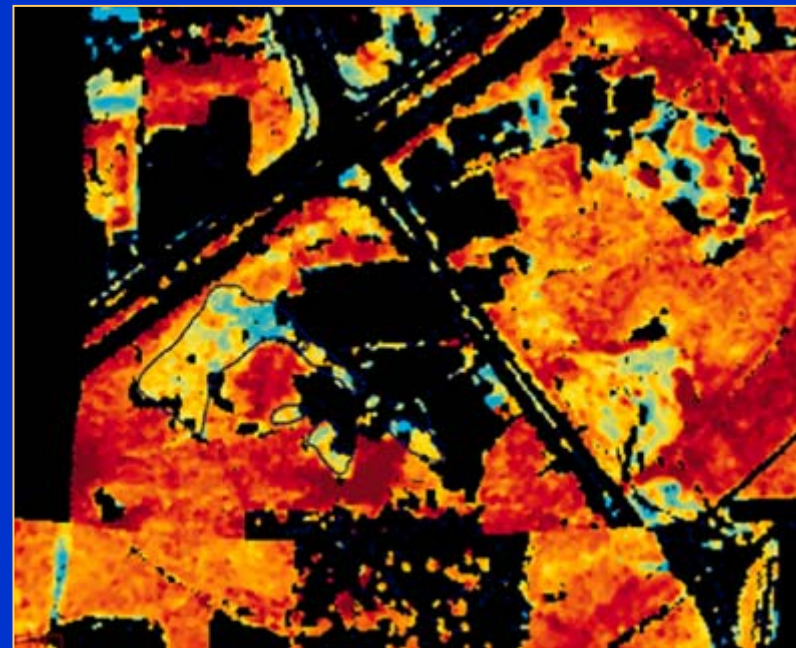
# Business Uses: Vegetation Stress and Environmental Liability



- Current Knowledge: Screen Properties
- Current Research: Identify Cause of Stress



**Neighboring Facility  
North of Pascagoula**



**Impact to Vegetation**

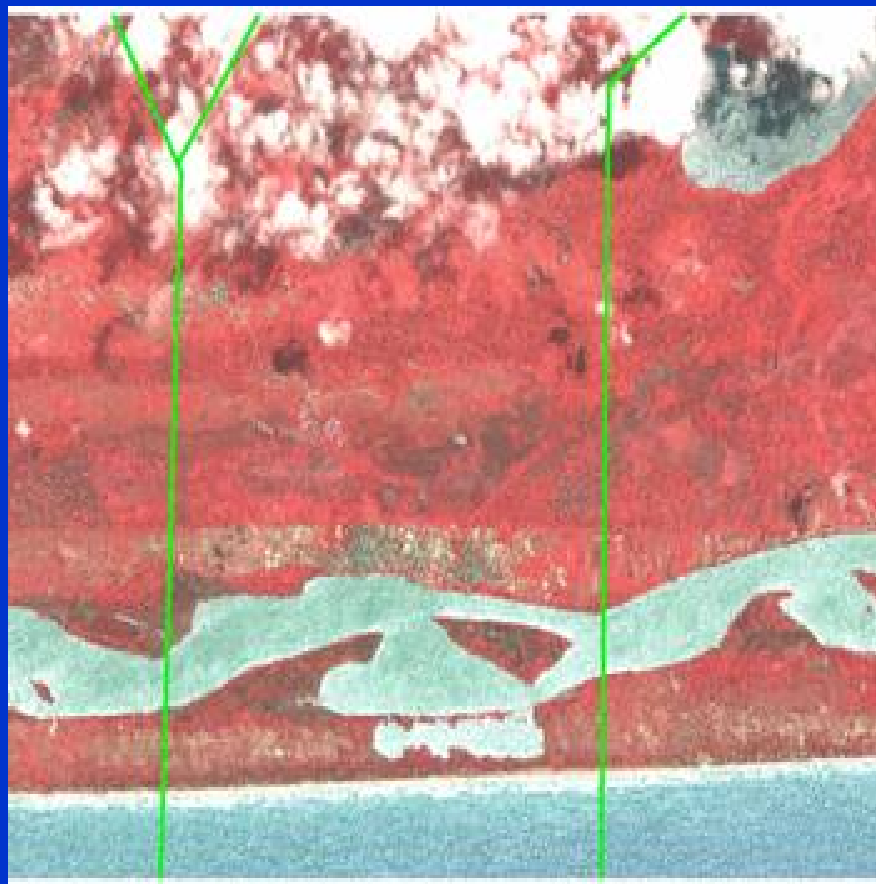


**Stressed**

**Healthy**



# Business Uses: Identify and Plan Infrastructure



- Used to Identify Environmental and Infrastructure Features for Pipeline Planning and Siting

# Business Use: Locate Hydrocarbon-Impacted Surfaces



U.S. West Coast



- Screen for Potential Hydrocarbon Impacted Sites
- Requires Some Field Verification

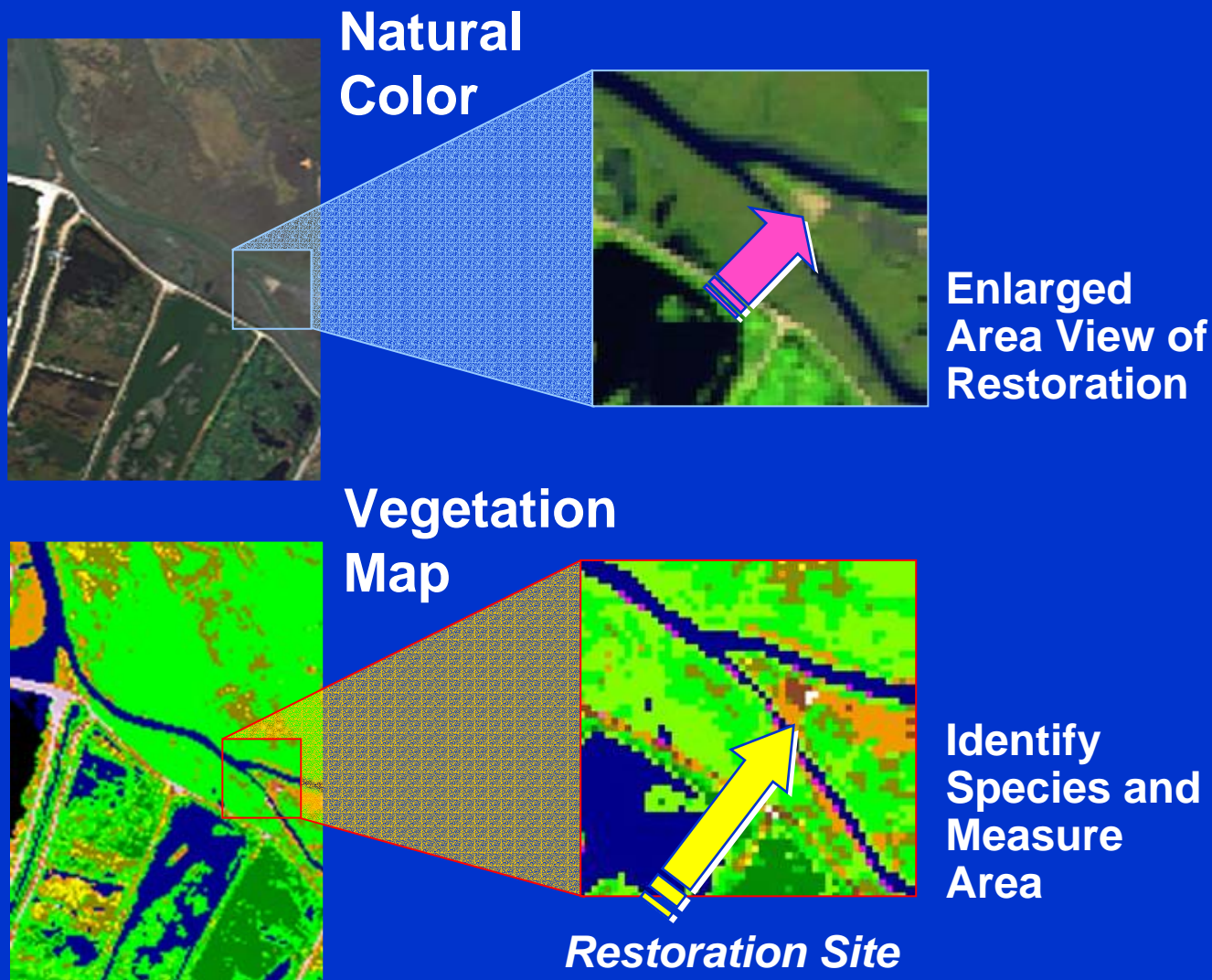




# Business Uses: Document the Restoration Actions



## Richmond Ecological Restoration



# Evolving Applications: Water Conditions



- Sediment or TSS
- Plant pigments
- Requires groundtruthing



San Francisco Bay

Images courtesy  
NASA/GSFC/MITI/ERSDAC/JAROS,  
and U.S./Japan ASTER Science Team

Jerry Ritchie, Hydrology and Remote Sensing  
Laboratory, USDA Agriculture Research Service.

# Oil slicks affect water in two important ways that are readily detected by Imaging Devices:



- **Spectral:** oil slicks increase reflectance in the visible through near-infrared portion of the electromagnetic spectrum.
- **Textural:** oil slicks smooth the sea surface, reducing the amount of reflected sun glint ("glitter") and radar backscatter.

# **Oil slicks affect water in two important ways that are readily detected by Imaging Devices:**



- **The type of detection (spectral vs. textural) depends on oil spill size, oil seepage rate, oil composition, sea state and illumination.**
- **Satellite imagery provides detailed data on the shape and size of natural oil slicks to pinpoint seep location and estimate seepage rates.**
- **Other oceanographic features (pollution, aquatic vegetation, phytoplankton blooms and coral spawn) may produce slicks on satellite imagery**

# Remote Sensing of Oil Spills on Water



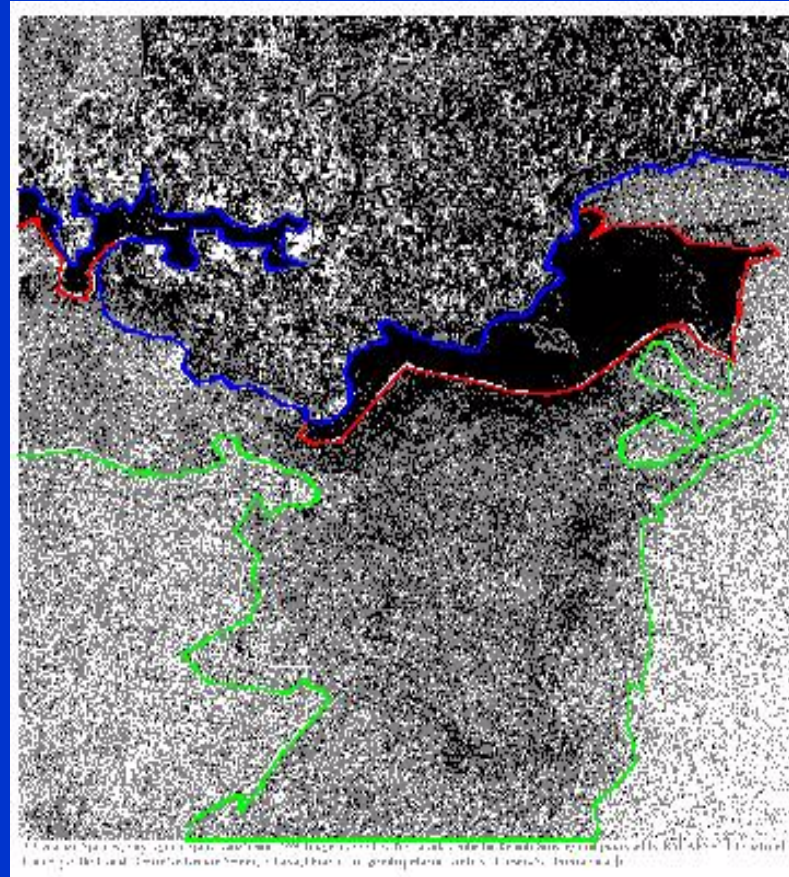
- **Typical Platforms**
  - Airplane
  - Satellite
- **Imaging**
  - Radar
  - Multispectral
  - Hyperspectral
  - Other (SLAR, FLIR, Aerial, Digital Photography)
- **Planning Periods**
  - Pre-Spill
  - Long Term Response Actions
  - Post Spill



# Oil Spill on Water – Radar Image



- Milford Haven, Wales, 22 February 1996
- Acquired by RadarSat (Canadian Radar Satellite Company) and analyzed by Canadian Center for Remote Sensing.
- “Sea Empress” supertanker spilled about 147,000 te crude oil.



Blue: Coastline

Red: Oil

Green: Oil with Dispersant

United Kingdom

# Tool for Oil Spill Planning, Response & Restoration



- **Pre-Spill Planning**
  - Environmental Sensitivity Index
  - Establishing Baseline
- **Emergency Response Phase**
  - Radar Applications
    - Oil Trajectory Calibration
  - Hyperspectral Applications
    - Resources at Risk
    - Oil Spill Nature And Extent Mapping
- **Post Emergency Response**
  - Nature & Extent of Oil
  - Oil Spill NRDA Studies
  - Oil Spill Restoration Planning and Monitoring

# Lessons Learned



- **Multiple Use of Data**
  - Serves many end users
    - Natural Resource Trustees
    - Public Affairs
    - Incident Command of Long Term Response
- **Products**
  - Take some time to get
    - Fastest – Quick Look
  - Great Looking Maps
    - Detailed Research Opportunities
    - Misinterpretation

# Lessons Learned



- **Equipment**
  - Availability during Emergency Phase Uncertain
  - Complex processing for images
  - Time consuming processing of data
- **Best used for pre-spill and post spill**
- **If available during ER Phase can provide valuable images for remote areas**
  - Operations can use to ID Boat ramps & Roads
  - Planning can use for Resources at Risk and SCAT